TETRA TECH

PHIL-25184-R1

April 29, 2013

Project Number 04635

Mr. Brad White (3HS22)
U.S. Environmental Protection Agency (EPA) Region 3
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Reference: Remedial Action Contract - EPA Region 3
EPA Contract Number EP-S3-07-04

Subject: Revised Round 2 ISCO Injection Approach
Valmont TCE Site
Long-Term Remedial Action (LTRA)
EPA Work Assignment No. 052-RALR-031M

Dear Mr. White:

This letter provides information regarding future implementation of the in-situ chemical oxidation (ISCO) remedy to address contaminated groundwater attributable to the site. More specifically the enclosure summarizes the revised approach for the next round of ISCO injections (i.e., Round 2) based on current TCE concentrations, post-injection monitoring results, past ISCO injection events, and recent EPA comments. The approach recommends the injection of roughly 9,200 gallons of oxidant solution into up to 16 wells and 20 intervals. Tetra Tech has not proposed well E-8 as part of this round.

Copies of this letter are being sent to Mindi Snoparsky of EPA and Len Zelinka of PADEP. Please contact me if you have any questions or comments.

Sincerely,

Neil Teamerson

Neil Teamerson
Project Manager

NT/pg

Attachment

c: Mindi Snoparsky (EPA Region 3)
Len Zelinka (PADEP)
Vince Shickora (Tetra Tech)
File No. 3

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ENCLOSURE

ROUND 2 ISCO INJECTION APPROACH
VALMONT TCE SITE
WEST HAZLETON BOROUGH AND HAZLE TOWNSHIP, PENNSYLVANIA

1.0 INVESTIGATION LOCATIONS AND ACCESS

The injection well locations are shown on Figure 1. Permission to perform injection work and other field tasks will be obtained by Tetra Tech and EPA. Most locations are on or adjacent to paved areas. Several locations are on a grass lawn where soft ground may be encountered. Two locations are inside the plant building. Vehicular and equipment access to these two locations is restricted by a 10 foot by 10-foot garage door. In addition, the ceiling height within the building is approximately 17 feet high. Tetra Tech will arrange for the garage door to be opened by the current tenant. The floor within the building consists of an approximate 6-inch thick concrete pad and contains steel reinforced rebar.

2.0 SCOPE OF WORK

A total of 16 wells have been selected to conduct injections at the site. Up to two zones (or intervals) will be utilized per well. Tetra Tech assumes that a double packer assembly will be used for most injections and that each packer will be inflated to the appropriate pressure for each zone. The assembly will be constructed to include a 10 to 20-foot spread between packers.

Water-level measurements and pressure readings will be taken from the injection well along with measurements from nearby wells to determine the influence of the injected volume of oxidant solution.

Tetra Tech assumes that a concentrated 10% sodium permanganate ($NaMnO_4$) solution will be utilized for the injections at the site.

The Tetra Tech field representative will make the final decision on all safety procedures. All Subcontractor personnel shall be required to attend a brief lecture on site-specific safety, to be given just before the commencement of work.

2.1 Task 1 - Mobilization/Demobilization

This task includes mobilizing all equipment, materials, and labor required to complete the project to the jobsite; setup of an equipment lay down area; per diem for a field crew, as needed; attendance of an approximately 1-hour site-specific health and safety meeting and compliance with all health and safety requirements for the project; site clean-up; demobilization from the site; and any other work items not mentioned in the remaining work tasks but necessary for the performance of the work activities.

A site-specific health and safety orientation meeting will be held during mobilization, prior to the initiation of any on-site activities. All Subcontractors shall meet the requirements of both OSHA 1910.120 and Tetra Tech as set forth in the Health and Safety Plan (HASP) (Tetra Tech, April 2011). The HASP will be available for review upon request. One orientation meeting will be held and all Subcontractor representatives and potential substitute personnel performing onsite work activities will be required to attend. No substitute personnel will be allowed to work without training. Personnel decontamination is discussed in the HASP.

The Drilling Subcontractor will provide 55-gallon drums for wastewater/decontamination water generated during injection activities. The drums will be stored at a centrally located area. It will be the responsibility of the Subcontractor to provide temporary, mobile holding tanks to support the following work:

- Collect and transport water and decontamination fluids
- Collect and transport the oxidant solution to locations near the selected injection wells
- Collect, haul, and transfer wastewater to the staging area

The Drilling Subcontractor will be responsible for providing and operating pumps for transferring wastewater on site. It is likely that any residual materials from injection activities will need to be contained and transported back to a central marshaling area.

2.2 Task 2 - Low to Moderate Pressure Injection Support Activities

This task includes two items.

- Task 2A - Initial Set-Up and Tear-Down
- Task 2B - Oxidant Solution Injections

2.2.1 Task 2A - Initial Set-Up and Teardown

The Drilling Subcontractor will provide all equipment, materials, and labor required to set up all of the required injection equipment at the site and to conduct any preliminary tasks to ensure the objectives of the work can be met. Initial activities may include any necessary trial runs or pilot testing to ensure that the oxidant solution can be successfully injected during Task 2A. Task 2A includes the effort to perform teardown activities related to injections.

2.2.2 Task 2B - Oxidant Injections

The Drilling Subcontractor will provide all equipment, materials, and labor required to perform injection activities at selected depths within the injection wells, including, but not limited to a portable 500 gallon permanganate holding tank, a double packer assembly (with 10-foot and 20-foot spreads), a suitable power source, water injection pumps capable of and suitable for injecting the oxidant solution under pressures ranging up to 200 psi and at depths ranging up to 100 feet, all required piping, pressure gauges and flow meters, and any necessary materials required to complete the injections.

The general procedure for each injection includes isolating the desired depth interval using a set of inflatable or mechanical packers (e.g., 5-foot packer), pumping the $NaMnO_4$ solution into the target interval under increasing pressures until a maximum pressure of approximately 200 psi occurs, continuing to inject the solution until the required volume has been injected into the specified interval. This procedure will be repeated for each targeted depth zone within the well typically starting with the deepest zone and working down to the shallowest.

The $NaMnO_4$ solution will be purchased by Tetra Tech and will be stored onsite in a 5,000-gallon poly tank. This tank will be positioned at a centrally located area of the site, most likely near wells MW-11S and MW-11D along the eastern side of the plant building. The oxidant solution will be pumped from the tank by the subcontractor into portable 500-gallon poly tank(s) and transferred to each injection well location as necessary. The 5,000-gallon tank will have secondary containment using dimensional lumber and plastic sheeting.

Work will begin at well E-1 and continue through well E-9. Well E-5 will be the last well used for injections. These wells are 8-inch diameter open-borehole wells. A dual packer assembly will generally be used for these wells. The packer inflation pressures will be at least 2,000 psi. The pressure generated during injections should be between 1-100 psi. However, the pumps used by the Drilling Subcontractor must be capable of achieving up to 200 psi at depths up to 100 feet below ground surface. The pressure and flow will be monitored by the use of in line gauges/meters. The total volume of oxidant solution to be injected into each 8-inch well zone is shown in Table 1. Example calculations of the volume required are provided as an attachment.

Work will then continue at the monitoring wells listed in Table 1. These wells are 2-inch diameter screened polyvinyl chloride (PVC) wells. A single packer assembly or a fitted connection (e.g., Fernco) may be used within each well. The packer inflation will be of sufficient pressure to complete each injection without damaging the PVC casing and at the same time preventing any day-lighting of the injection solution. The pressure generated during injections should be between 1-100 psi. However,

the pumps utilized by the Drilling Subcontractor must be capable of achieving up to 200 psi at depths up to 290 feet below ground surface. The pressure and flow will be monitored by in line gauges/meters. The total volume of solution to be injected into each 2-inch diameter well zone is included in Table 1.

The Subcontractor must demonstrate that the fitted connection (if used) provides a comparable measure of effectiveness for injections into monitoring wells. Two measures of effectiveness are the capability of the fitted connection to prevent surfacing of the oxidant solution as well as to allow for pressure injections into low yielding wells.

The Subcontractor must demonstrate that the fitted connection will meet the objectives of the injection program. Leak testing using only water must be performed to fulfill this demonstration. If the 2-inch PVC riser is damaged, or if leak testing is unsuccessful, the single packer approach will be used. The Tetra Tech field representative, and not the Subcontractor, is responsible for making the decision as to whether the fitted connection is appropriate.

Prior to the start of injections at individual wells, the field team will place pressure transducers in nearby wells to monitor relative changes in water-level elevations. For planning, Tetra Tech assumes that up to six transducers will be used during the course of the Round 2 ISCO injections as follows:

PRESSURE TRANSDUCERS							
E-1	**E-2**	**E-3**	**E-4**	**E-5**	**E-6**	**E-7**	**E-9**
MW-10B	MW-11S	MW-12S	MW-10B	MW-2S	MW-18S	MW-10B	E-6
MW-10C	MW-11D	MW-12I	MW-10C	MW-2I	MW-12S	MW-10C	MW-13S
MW-15S	MW-15S	MW-18	MW-28S	MW-14S	MW-12I	MW-15S	MW-13I
MW-15I	MW-15I	E-6	MW-28I	MW-14D	E-9	MW-15D	MW-18S
MW-28S	MW-28S		MW-15S	MW-13S	MW-28S	MW-6S	MW-28S
MW-28I	E-8		MW-15I	MW-13D	MW-28I	MW-6I	MW-28I

PRESSURE TRANSDUCERS						
MW-10A	**MW-11S**	**MW-11D**	**MW-12S**	**MW-13S**	**MW-13I**	**MW-28S**
MW-10B	MW-11D	MW-15D	E-3	MW-2S	MW-13S	MW-28I
MW-10C	MW-15S	MW-28I	MW-12I	MW-2I	MW-2S	MW-11S
MW-15S	MW-28S	E-8	MW-18S	MW-13D	MW-2I	MW-15S
MW-15I	E-8	MW-15S	E-6	E-5	E-5	MW-15I
		MW-15I				MW-10B
						MW-10C

Transducers will not be used for injections at well MW-22D due the depth of this well. Tetra Tech will use the pressure transducer results to evaluate the radius of influence (ROI) associated with injections.

The field team will stop injections in the event that receiving wells indicate that surfacing of the oxidant solution may occur (also referred to as day lighting). Tetra Tech will adjust the flow rate of the injection pump to allow for stabilization of the water level in each receiving well, to obtain a consistent flow of

oxidant solution, and to prevent day lighting. Containment pads will be installed around the injection wells to contain any possible spills as follows:

CONTAINMENT PAD WELLS DURING INJECTIONS							
E-1	**E-2**	**E-3**	**E-4**	**E-5**	**E-6**	**E-7**	**E-9**
MW-10B MW-10C	MW-11S MW-11D MW-15S MW-15I MW-28S MW-28I	MW-12S MW-12I MW-18 E-6	MW--12S MW-12I MW-28S MW-28I MW-18	None	None	MW-15S MW-15D	E-6

CONTAINMENT PAD WELLS DURING INJECTIONS						
MW-10A	**MW-11S**	**MW-11D**	**MW-12S**	**MW-13S**	**MW-13I**	**MW-28S**
MW-10B E-1	MW-11D MW-15S MW-28S E-2	E-2 MW-15D MW-28I	E-3 MW-12I MW-18S	MW-13D	MW-13S	MW-28I

A dilute (3-6%) sodium thiosulfate solution will be available for neutralization of spills and decon of equipment. Sorbent materials such as vermiculate or kitty litter will also be available for spill containment. For personal decontamination, the team will use a dilute hydrogen peroxide/vinegar/water solution. The field team will containerize all wastes in 55-gallon drums for off-site disposal following completion of injection activities.

Round 2 ISCO injections may be limited by the amount of $NaMnO_4$ solution each receiving well can accept, particularly for screened monitoring wells. To the extent practicable, Tetra Tech will inject the volumes listed in Table 1. For planning, however, the following guidelines will support decision-making in the field regarding the injection program:

1. Surfacing of the oxidant solution will result in immediate cessation of injection activities at a well interval. The team will take precautions for those wells with two targeted intervals if the deepest interval injections previously resulted in surfacing.

2. Pressures greater than 40 psi will not be exceeded during injections. Well intervals unable to receive the oxidant solution at this pressure will not be used for injections.

3. For monitoring (screened) wells containing TCE concentrations greater than 500 ug/L and unable to receive an average flow rate of at least 2 gpm, injections will continue for 4 hours if average flow is less than 0.5 gpm, or for 2 hours if average flow is between 0.5 and 1 gpm. This rule may apply to wells MW-10A, MW-11S, MW-12S, and MW-28S.

4. For monitoring wells containing TCE levels between 100 and 500 ug/L, and unable to receive an average flow of at least 1 gpm, injections will continue for 2 hours if average flow is less than 0.5 gpm, or will continue for 1 hours if average flow is between 0.5 and 1 gpm. This rule may apply to wells MW-11D, MW-13S, MW-13I, and MW-22D.

5. For all injection (open borehole) wells unable to receive an average flow of at least 5 gpm, injections will continue for up to 4 hours.

2.3 Task 3 - Borehole Geophysical Logging

The purpose of this optional task is to evaluate the condition of two existing wells for possible future injection work as part of implementing the groundwater remedy at the site. Borehole geophysical logging may be required for two former residential drinking water wells (i.e., GW-21 and GW-23) along Bent Pine Trail/Road. Both wells are 6-inch open boreholes with estimated depths between 180 and 190 feet. The Geophysical Logging Subcontractor should assume that the pumps and other appurtenances are removed from these wells, that both wells are cased to 25 feet below the ground surface, and that access to conduct the work has been granted. Former well GW-9 will not be logged since it is in close proximity to existing well MW-29.

Traditional borehole geophysical logging methods will be used for this task, including:

- Gamma ray
- Temperature
- Fluid resistivity
- Heat pulse flowmeter
- Normal resistivity
- Acoustic televiewer (ATV)
- Caliper

The geophysical logs and video logs shall be reviewed by the Tetra Tech field representative immediately after their generation. The Geophysical Logging Subcontractor shall supply the equipment necessary to view the video. Copies of all recorded logs will be delivered to Tetra Tech within five business days of completion of field activities.

At this time, packer tests are not considered part of the Round 2 ISCO injection scope of work, if directed by EPA, packer tests will be conducted to obtain water quality and yield information from discrete

groundwater zones encountered within wells GW-21 and GW-23. The zone(s) to be tested within the borehole will be identified by reviewing borehole geophysical logs.

A dual-packer assembly is required, although only the upper packer may be needed for some tests conducted near the bottom of the borehole. The standard packer spread (measured from the bottom of the top packer to the top of the bottom packer) will be about 10 feet. However, it is possible that a longer or shorter spread will be required depending on the vertical distribution of fractures and the need to either include or exclude selected fractures from each test. Therefore, the spread of the packers shall be adjustable so that discrete zones of varying length can be isolated in the borehole. To minimize the number of packer adjustments, packer testing will be designed to first test all zones requiring the standard packer spread, and then test the zones requiring a shorter or longer packer spread.

Hydraulic head monitoring of the formation above and below the packer will be conducted during the packer tests. The yields from the isolated fractures are estimated to range from less than 1 to 3 gallon per minutes. The Geophysical Logging Subcontractor will supply either a variable speed pump or a low-yield pump to evacuate the packered interval, so estimates of approximate yield may be made, and groundwater samples to be analyzed for volatile organic contaminants may be obtained directly from the pump discharge.

2.4 Task 4 - Waste Management and Oxidant Delivery

The Waste Management Subcontractor will deliver and provide one 5,000-gallon poly tank to store the oxidant solution. The tank will be stored on the eastern side of the plant building. At the conclusion of Round 2 injection work, the Subcontractor will clean the poly tank and remove it from the site. It is assumed that the poly tank will not remain at the site for more than 2 weeks.

Any wastes generated during Round 2 will be containerized and transported off-site for disposal. The more likely wastes include wastewaters from the injection program, any spills that require neutralization, materials captured by containment structures around injection wells or monitoring wells, and materials captured at the decontamination pad. Tetra Tech assumes that up to five 55-gallon drums may be required for waste management.

Tetra Tech will issue a purchase order for the delivery of the pre-mixed 10% $NaMnO_4$ solution. The liquid $NaMnO_4$ material will be provided by the manufacturer, sent to an off-site blender in northern New Jersey, mixed to specifications, and delivered to the site in 5,000-gallon tankers. The tanker contents will be transferred to the 5,000-gallon tank. Two tanker deliveries are anticipated (total of 9,200 gallons) and will be scheduled several days apart to support the injection program.

2.5 Task 5 - Post-Injection Support Activities

Upon completion of the injection work, the Subcontractors shall remove all equipment, unused materials, and debris from the site. The site shall be restored as nearly as practical to its condition before the work began. All structures or property damaged due to the Subcontractor's negligence shall be restored at their expense as nearly as possible to their original condition. All cleanup and restoration of the property shall be to the complete satisfaction of Tetra Tech.

The Drilling Subcontractor shall be required to decontaminate the equipment and materials needed in the performance of the work as described below. The Subcontractor will perform the decontamination at a location designated by Tetra Tech. Decontamination of down-hole equipment and pumps shall consist of the following:

- Spray neutralization with sodium thiosulfate solution (if necessary)
- Pressure wash equipment using steam genie and potable water
- Rinse equipment using potable water

3.0 SCHEDULE

The anticipated start date for Injection activities is on or around May 20, 2013. The period of performance will be set for June 7, 2013.

TABLE 1
ROUND 2 ISCO INJECTION APPROACH
VALMONT TCE SITE
WEST HAZLETON BOROUGH AND HAZLE TOWNSHIP, PENNSYLVANIA

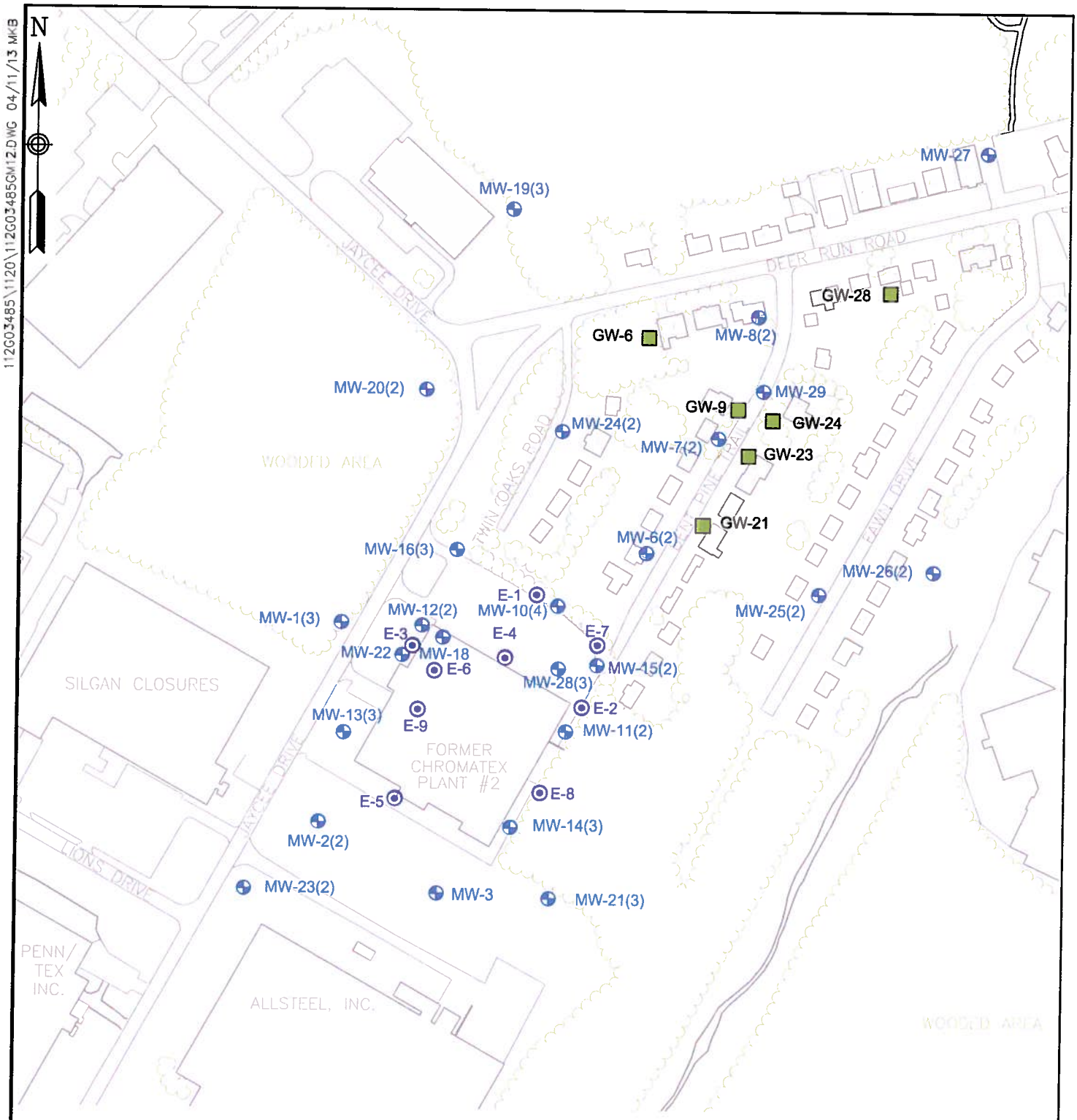
WELL	INJECTION VOLUME (gallons)	INTERVALS (in feet bgs)		TCE CONCENTRATION (µg/L)	COMMENTS
E-1	2,178	20-40	60-80	780	Double packer setup; injection volume has been doubled
E-2	545	32-52	NA	220	Double packer setup
E-3	545	40-60	NA	500 (assumed)	Double packer setup
E-4	2,180	30-50	65-85	1,600	Double packer setup; injection volume has been doubled
E-5	726	43-63	80-100	92	Double packer setup (4)
E-6	545	30-50	NA	500 (assumed)	Indoors; double packer setup
E-7	1,090	18-38	40-60	160	Double packer setup
E-8	NA	NA	NA	NA	Injections not anticipated
E-9	273	30-40	NA	1,600	Indoors; single or double packer setup; injection volume has been doubled
MW-10A	136	36-46	NA	710	Single packer setup
MW-11S	136	44-54	NA	3,100	Single packer setup; injection volume has been doubled
MW-11D	136	96-106	NA	370	Single packer setup
MW-12S	177	45-58	NA	1,200	Single packer setup; injection volume has been doubled
MW-13S	136	20-35	NA	300J	Single packer setup
MW-13I	136	78-88	NA	140	Single packer setup
MW-22D	136	294-304	NA	260 (assumed)	Single packer setup
MW-28S	136	35-45	NA	870 (assumed)	Single packer setup; injection volume has be doubled
TOTAL	9,211				

(1) First tanker for wells E-1, E-2, E-4, and MW-10A (5,000 gals of 10% oxidant solution).

(2) Second tanker for other wells (E-3, E-5, E-6, E-7, E-9, MW-12S, MW-13S, MW-13I, MW-22D, MW-28S (4,200 gals of 10% solution).

(3) Priority wells have TCE concentrations >750 µg/L, including wells E-1, E-4, E-9, MW-11S, and MW-12S.

(4) Last injection will be at well E-5.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

EXISTING WELL NETWORK
VALMONT TCE SITE
HAZLE TOWNSHIP AND
WEST HAZLETON BOROUGH
LUZERNE COUNTY, PENNSYLVANIA

SCALE	AS NOTED
FILE	112G03485GM12
REV	0
DATE	04/11/13
FIGURE NUMBER	FIGURE 1

ATTACHMENT

RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with blue font

Site Name: Valmont TCE Site, W. Hazleton, PA (Well E-1)
Date: 4/11/2013

	Estimates	Units	
Treatment Area Volume			
Length	90	ft	
Width	60	ft	
Area	5400	sq ft	
Thickness	40	ft	
Total Volume	8000	cu yd	
Soil Characteristics/Analysis			
Porosity	1.2	%	
Total Plume Pore Volume	19390	gal	
Avg Contaminant Conc	0.1	ppm	
Mass of Contaminant	0.02	lb	
PNOD	3.1	g/kg	
Effective PNOD	1	%	
Effective PNOD Calculated	0.031		
PNOD Oxidant Demand	736.56	lb	
Avg Stoichiometric Demand	2.4	lb/lb	
Contaminant Oxidant Demand	0.04	lb	
Theoretical Oxidant Demand	736.60	lb	
Confidence Factor	3		
Calculated Oxidant Demand	2209.797		
Injection Volumes for RemOx L			
RemOx L Injection Concentration	10.0%	%	
Calculated Specific Gravity	1.091623	g/ml	
Total Volume of Injection Fluid	2,178	gal	Two intervals; 1,089 gals/interval
Pore Volume Replaced	11.23	%	

Amount of RemOx L ISCO Reagent Estimated **4,961 pounds**
434 gallons

RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with blue font

Site Name: Valmont TCE Site, W. Hazleton, PA (Well E-2)
Date: 4/11/2013

	Estimates	Units	
Treatment Area Volume			
Length	90	ft	
Width	60	ft	
Area	5400	sq ft	
Thickness	20	ft	
Total Volume	4000	cu yd	
Soil Characteristics/Analysis			
Porosity	1.2	%	
Total Plume Pore Volume	9695	gal	
Avg Contaminant Conc	0.22	ppm	
Mass of Contaminant	0.02	lb	
PNOD	3.1	g/kg	
Effective PNOD	1	%	
Effective PNOD Calculated	0.031		
PNOD Oxidant Demand	368.28	lb	
Avg Stoichiometric Demand	2.4	lb/lb	
Contaminant Oxidant Demand	0.04	lb	
Theoretical Oxidant Demand	368.32	lb	
Confidence Factor	1.5		
Calculated Oxidant Demand	552.4841		
Injection Volumes for RemOx L			
RemOx L Injection Concentration	10.0%	%	
Calculated Specific Gravity	1.091623	g/ml	One interval: 32-52 feet
Total Volume of Injection Fluid	545	gal	
Pore Volume Replaced	5.62	%	

Amount of RemOx L ISCO Reagent Estimated **1,240 pounds**
109 gallons

RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with blue font

Site Name: Valmont TCE Site, W. Hazleton, PA (Well E-3)
Date: 4/11/2013

	Estimates	Units
Treatment Area Volume		
Length	90	ft
Width	60	ft
Area	5400	sq ft
Thickness	20	ft
Total Volume	4000	cu yd
Soil Characteristics/Analysis		
Porosity	1.2	%
Total Plume Pore Volume	9695	gal
Avg Contaminant Conc	0.5	ppm
Mass of Contaminant	0.04	lb
PNOD	3.1	g/kg
Effective PNOD	1	%
Effective PNOD Calculated	0.031	
PNOD Oxidant Demand	368.28	lb
Avg Stoichiometric Demand	2.4	lb/lb
Contaminant Oxidant Demand	0.10	lb
Theoretical Oxidant Demand	368.38	lb
Confidence Factor	1.5	
Calculated Oxidant Demand	552.5656	
Injection Volumes for RemOx L		
RemOx L Injection Concentration	10.0%	%
Calculated Specific Gravity	1.091623	g/ml
Total Volume of Injection Fluid	545	gal
Pore Volume Replaced	5.62	%

Amount of RemOx L ISCO Reagent Estimated **1,241 pounds**
109 gallons

RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with blue font

Site Name: Valmont TCE Site, W. Hazleton, PA (Well E-4)
Date: 4/11/2013

	Estimates	Units	
Treatment Area Volume			
Length	90	ft	
Width	60	ft	
Area	5400	sq ft	
Thickness	40	ft	
Total Volume	8000	cu yd	
Soil Characteristics/Analysis			
Porosity	1.2	%	
Total Plume Pore Volume	19390	gal	
Avg Contaminant Conc	1.6	ppm	
Mass of Contaminant	0.26	lb	
PNOD	3.1	g/kg	
Effective PNOD	1	%	
Effective PNOD Calculated	0.031		
PNOD Oxidant Demand	736.56	lb	
Avg Stoichiometric Demand	2.4	lb/lb	
Contaminant Oxidant Demand	0.62	lb	
Theoretical Oxidant Demand	737.18	lb	
Confidence Factor	3		
Calculated Oxidant Demand	2211.544		
Injection Volumes for RemOx L			
RemOx L Injection Concentration	10.0%	%	
Calculated Specific Gravity	1.091623	g/ml	
Total Volume of Injection Fluid	2,180	gal	Two intervals; 1,090 gals/interval
Pore Volume Replaced	11.24	%	

Amount of RemOx L ISCO Reagent Estimated **4,965 pounds**
434 gallons

RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with blue font

Site Name: Valmont TCE Site, W. Hazleton, PA (Well E-5)
Date: 4/29/2013

	Estimates	Units	
Treatment Area Volume			
Length	90	ft	
Width	60	ft	
Area	5400	sq ft	
Thickness	40	ft	
Total Volume	8000	cu yd	
Soil Characteristics/Analysis			
Porosity	1.2	%	
Total Plume Pore Volume	19390	gal	
Avg Contaminant Conc	0.92	ppm	
Mass of Contaminant	0.15	lb	
PNOD	3.1	g/kg	
Effective PNOD	1	%	
Effective PNOD Calculated	0.031		
PNOD Oxidant Demand	736.56	lb	
Avg Stoichiometric Demand	2.4	lb/lb	
Contaminant Oxidant Demand	0.36	lb	
Theoretical Oxidant Demand	736.92	lb	
Confidence Factor	1		
Calculated Oxidant Demand	736.9173		
Injection Volumes for RemOx L			
RemOx L Injection Concentration	10.0%	%	
Calculated Specific Gravity	1.091623	g/ml	Two intervals; 363 gals/interval
Total Volume of Injection Fluid	726	gal	
Pore Volume Replaced	3.75	%	

Amount of RemOx L ISCO Reagent Estimated **1,654 pounds**
145 gallons

RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with blue font

Site Name: Valmont TCE Site, W. Hazleton, PA (Well E-6)
Date: 4/11/2013

	Estimates	Units
Treatment Area Volume		
Length	90	ft
Width	60	ft
Area	5400	sq ft
Thickness	20	ft
Total Volume	4000	cu yd
Soil Characteristics/Analysis		
Porosity	1.2	%
Total Plume Pore Volume	9695	gal
Avg Contaminant Conc	0.5	ppm
Mass of Contaminant	0.04	lb
PNOD	3.1	g/kg
Effective PNOD	1	%
Effective PNOD Calculated	0.031	
PNOD Oxidant Demand	368.28	lb
Avg Stoichiometric Demand	2.4	lb/lb
Contaminant Oxidant Demand	0.10	lb
Theoretical Oxidant Demand	368.38	lb
Confidence Factor	1.5	
Calculated Oxidant Demand	552.5656	
Injection Volumes for RemOx L		
RemOx L Injection Concentration	10.0%	%
Calculated Specific Gravity	1.091623	g/ml
Total Volume of Injection Fluid	545	gal
Pore Volume Replaced	5.62	%

Amount of RemOx L ISCO Reagent Estimated — **1,241 pounds**
109 gallons

RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with blue font

Site Name: Valmont TCE Site, W. Hazleton, PA (Well E-7)
Date: 4/11/2013

	Estimates	Units	
Treatment Area Volume			
Length	90	ft	
Width	60	ft	
Area	5400	sq ft	
Thickness	40	ft	
Total Volume	8000	cu yd	
Soil Characteristics/Analysis			
Porosity	1.2	%	
Total Plume Pore Volume	19390	gal	
Avg Contaminant Conc	0.16	ppm	
Mass of Contaminant	0.03	lb	
PNOD	3.1	g/kg	
Effective PNOD	1	%	
Effective PNOD Calculated	0.031		
PNOD Oxidant Demand	736.56	lb	
Avg Stoichiometric Demand	2.4	lb/lb	
Contaminant Oxidant Demand	0.06	lb	
Theoretical Oxidant Demand	736.62	lb	
Confidence Factor	1.5		
Calculated Oxidant Demand	1104.933		
Injection Volumes for RemOx L			
RemOx L Injection Concentration	10.0%	%	Two intervals; 545 gals/interval
Calculated Specific Gravity	1.091623	g/ml	
Total Volume of Injection Fluid	1,089	gal	
Pore Volume Replaced	5.62	%	

Amount of RemOx L ISCO Reagent Estimated **2,481 pounds**
217 gallons

RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with blue font

Site Name: Valmont TCE Site, W. Hazleton, PA (Well E-9)
Date: 4/11/2013

	Estimates	Units
Treatment Area Volume		
Length	90	ft
Width	60	ft
Area	5400	sq ft
Thickness	10	ft
Total Volume	2000	cu yd
Soil Characteristics/Analysis		
Porosity	1.2	%
Total Plume Pore Volume	4847	gal
Avg Contaminant Conc	1.6	ppm
Mass of Contaminant	0.06	lb
PNOD	3.1	g/kg
Effective PNOD	1	%
Effective PNOD Calculated	0.031	
PNOD Oxidant Demand	184.14	lb
Avg Stoichiometric Demand	2.4	lb/lb
Contaminant Oxidant Demand	0.16	lb
Theoretical Oxidant Demand	184.30	lb
Confidence Factor	1.5	
Calculated Oxidant Demand	276.443	
Injection Volumes for RemOx L		
RemOx L Injection Concentration	10.0%	%
Calculated Specific Gravity	1.091623	g/ml
Total Volume of Injection Fluid	273	gal
Pore Volume Replaced	5.62	%

Amount of RemOx L ISCO Reagent Estimated **621 pounds**
54 gallons

CARUS REMEDIATION TECHNOLOGIES

In Situ Chemical Oxidation (ISCO) *In Situ Bioremediation (BIO)* *In Situ Biogeochemical Stabilization (ISBS)*

RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with blue font

Site Name: Valmont TCE Site, W. Hazleton, PA (Wells MW-11S, 11D, 10A, 28S, 22D, 13I)
Date: 4/29/2013

	Estimates	Units	
Treatment Area Volume			
Length	45	ft	
Width	30	ft	
Area	1350	sq ft	
Thickness	10	ft	
Total Volume	500	cu yd	
Soil Characteristics/Analysis			
Porosity	1.2	%	
Total Plume Pore Volume	1212	gal	
Avg Contaminant Conc	1	ppm	
Mass of Contaminant	0.01	lb	
PNOD	3.1	g/kg	
Effective PNOD	1	%	
Effective PNOD Calculated	0.031		
PNOD Oxidant Demand	46.035	lb	
Avg Stoichiometric Demand	2.4	lb/lb	
Contaminant Oxidant Demand	0.02	lb	
Theoretical Oxidant Demand	46.06	lb	
Confidence Factor	3		
Calculated Oxidant Demand	138.1778		
Injection Volumes for RemOx L			
RemOx L Injection Concentration	10.0%	%	10-Foot Screened Wells
Calculated Specific Gravity	1.091623	g/ml	
Total Volume of Injection Fluid	136	gal	
Pore Volume Replaced	11.24	%	

Amount of RemOx L ISCO Reagent Estimated **310 pounds**
27 gallons

RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with blue font

Site Name: Valmont TCE Site, W. Hazleton, PA (Well MW-12S)
Date: 4/29/2013

	Estimates	Units	
Treatment Area Volume			
Length	45	ft	
Width	30	ft	
Area	1350	sq ft	
Thickness	13	ft	
Total Volume	650	cu yd	
Soil Characteristics/Analysis			
Porosity	1.2	%	
Total Plume Pore Volume	1575	gal	
Avg Contaminant Conc	1	ppm	
Mass of Contaminant	0.01	lb	
PNOD	3.1	g/kg	
Effective PNOD	1	%	
Effective PNOD Calculated	0.031		
PNOD Oxidant Demand	59.8455	lb	
Avg Stoichiometric Demand	2.4	lb/lb	
Contaminant Oxidant Demand	0.03	lb	
Theoretical Oxidant Demand	59.88	lb	
Confidence Factor	3		
Calculated Oxidant Demand	179.6312		
Injection Volumes for RemOx L			
RemOx L Injection Concentration	10.0%	%	13-Foot Screened Well
Calculated Specific Gravity	1.091623	g/ml	
Total Volume of Injection Fluid	177	gal	
Pore Volume Replaced	11.24	%	

Amount of RemOx L ISCO Reagent Estimated **403 pounds**
35 gallons

RemOx® L ISCO Reagents Estimation Spreadsheet

Input data into box with blue font

Site Name: Valmont TCE Site, W. Hazleton, PA (Well MW-13S)
Date: 4/29/2013

	Estimates	Units	
Treatment Area Volume			
Length	45	ft	
Width	30	ft	
Area	1350	sq ft	
Thickness	15	ft	
Total Volume	750	cu yd	
Soil Characteristics/Analysis			
Porosity	1.2	%	
Total Plume Pore Volume	1818	gal	
Avg Contaminant Conc	1	ppm	
Mass of Contaminant	0.02	lb	
PNOD	3.1	g/kg	
Effective PNOD	1	%	
Effective PNOD Calculated	0.031		
PNOD Oxidant Demand	69.0525	lb	
Avg Stoichiometric Demand	2.4	lb/lb	
Contaminant Oxidant Demand	0.04	lb	
Theoretical Oxidant Demand	69.09	lb	
Confidence Factor	2		
Calculated Oxidant Demand	138.1778		
Injection Volumes for RemOx L			
RemOx L Injection Concentration	10.0%	%	15-Foot Screened Well
Calculated Specific Gravity	1.091623	g/ml	
Total Volume of Injection Fluid	136	gal	
Pore Volume Replaced	7.49	%	

Amount of RemOx L ISCO Reagent Estimated **310 pounds**
27 gallons